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THE

DESCRIPTION AND USE

OF THE

SLIDING RULE

IN THE MENSURATION OF

WOOD, STONE, BALES, &c.

ALSO,

THE DESCRIPTION OF THE SHIP-CARPENTERS

SLIDING RULE,

AND ITS USE APPLIED TO THE CONSTRUCTION OF

MASTS, YARDS, &c.

BY

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LONDON:
PRINTED FOR W. HEATHER, NAVIGATION WAREHOUSE, LEADENHALL STREET, AND J. WHITE, FLEET STREET, *LONDON;*
A. CONSTABLE, *EDINBURGH;*
AND J. MATTHEWS ON THE QUAY, *ABERDEEN.*

1799.

Entered in Stationers Hall.

BRITISH MUSEUM

PREFACE.

THE SLIDING RULE is an inſtrument of ſo extenſive uſe, particularly in the menſuration of wood, ſtone, glaſs, painting, plaſtering, &c. that it ought to be in the hands of every artificer.

IN order, therefore, to aſſiſt thoſe who may ſtill be unacquainted with the nature and uſe of this inſtrument, the following conciſe and plain directions were drawn up; and which, it is preſumed, will alſo be found of ſervice to thoſe who have ſome previous knowledge of this ſubject. In theſe directions, plainneſs and perſpicuity have chiefly been aimed at, inſomuch, that it is hoped they will be found ſufficiently intelligible even without the aſſiſtance of a teacher.

THAT this ſmall Treatiſe may be farther uſeful to artificers of every denomination, another Sliding Rule, employed by ſhip-carpenters, and commonly known by the name of MUNGO MURRAY's Rule, is alſo deſcribed, and its uſe exemplified in determining the dimenſions of maſts and yards, and in the conſtruction of them; and alſo in making ten and twelve ſquare barrels for capſtans. This laſt will alſo be found uſeful to joiners and others in making columns, &c.

ABERDEEN,
17th October 1799.

THE

DESCRIPTION AND USE

OF THE

SLIDING RULE.

CHAP. I.

Containing the Deſcription of the Sliding Rule, and its Uſe applied to Arithmetic.

SECT. I.

The Deſcription of the Sliding Rule.

THIS rule is formed of two pieces of wood each a foot long, and connected by a joint: in one of theſe pieces is a ſlip of wood or braſs, ſliding in a groove; and hence the name of the rule.

The principal lines on this rule are thoſe on that part in which is the ſlide. Theſe are, three lines called *lines of numbers;* two of which are upon the ſlide, marked B and C at the right hand extremity; and one above, marked A. The line below the ſlide is called the *girt line*, and is marked D. Upon the other parts of the rule are various lines or tables, according to the fancy of the maker, or the uſe for which it is intended. Thus on the ſame ſide of the rule in which is the ſlide, but on the other part, there is put on ſome rules a table expreſſing the value of a load of wood containing 50 cubical feet, from 6d. to 2s. per ſolid foot. For example, at 6d. per foot, the value of the load is L. 1, 5s.; at $6\frac{1}{4}$d. the value is L. 1, 6s.; at $6\frac{1}{2}$d. it is L. 1, 7s. 1d.; at $6\frac{3}{4}$d. the value is L. 1, 8s. 1d. &c. Again, on other rules, there is a table exhibiting the value of an hundred weight, or 112 lbs. from a farthing to a ſhilling per cwt. Thus at one farthing per lb. the cwt. will amount to L. 0, 2s. 4d.; at $4\frac{3}{4}$d. per lb. the value of the cwt. is L. 2, 4s. 4d. Other rules have a table containing the length of a rope or cable of a given circumference that will make a hundred weight. Thus of a rope 6 inches in circumference, it will require 13 fathoms 3 feet to make a cwt. On other rules are the proportional dimenſions of maſts and yards, ſcales for ſquaring yards, capſtans, &c.

Upon the other ſide of the rule are ſcales of inches, and parts of an inch, or the ſectoral lines, &c.

OF THE LINE OF NUMBERS.

THE line of numbers is divided into two equal parts; each of theſe parts is divided into ten unequal parts; and each of theſe parts is ſubdivided into ten or more parts.

If the 1 at the beginning of the line repreſents 1, the next primary diviſion repreſents 2, the third 3, and ſo on; the 1 at the middle of the line repreſents 10; the next primary diviſion 20, and the 1 at the end of the line repreſents 100. But if the 1 at the beginning of the line denotes 10, then the 1 at the middle of the line repreſents 100, and the 1 at the end repreſents 1000; and the intermediate diviſions are to be eſtimated accordingly. Hence it may be obſerved, that the numbers in the ſecond half of the line are ten times the correſponding numbers in the firſt half; and hence the following rule to find the place of any propoſed number on the line will be obvious.

Among the primary diviſions, take the ſame as in the higheſt figure in the given number; among the intermediate principal diviſions, take that which is the ſame as the ſecond higheſt figure; and for the other figures, a proportional part of the ſpace between the laſt found and the next following of the principal intermediate diviſions is to be taken by eſtimation.

EXAMPLES.

1. Required the point repreſenting 49?

The primary diviſion 4 on either half is to be reckoned 40; and numbering forward to the right hand until the 9th of the principal intermediate diviſions will be the point repreſenting 49. This point may alſo repreſent 490, 4900, &c.

2. Required the point repreſenting 164?

The 1 at the beginning or middle of the line is to be eſteemed 100. In this caſe, therefore, the next primary diviſion 2 denotes 200. Now reckon forward from 100 among the principal intermediate diviſions until the 6th, which point will therefore repreſent 160; and ſince the interval between 160 and 170 is divided into 5 parts, each of theſe parts is therefore to be eſtimated 2; and becauſe the unit figure of the propoſed number is 4, reckon forward two diviſions; this laſt point will therefore be the place repreſenting 164.

3. The point on the line of numbers repreſenting 543 is required?

The primary diviſion 5 on the line will repreſent 500, and of the intermediate principal diviſions 4 will repreſent 540. Now the interval between 540 and 550 being ſuppoſed to be divided into ten parts, then the third diviſion, taken by eſtimation from 540, will be the point repreſenting 543.

4. The place of 1798 on the line of numbers is required?

The 1 at the beginning or middle of the line is to be taken as 1000, and reckoning forward to the 7th of the principal intermediate diviſions, will be the place of 1700; the 4th of the ſubdiviſions will be the place of 1780; the interval between which and the next diviſion 1800 is 20, of which the 18th diviſion being taken by eſtimation will be the place repreſenting 1798.

SECT. II.

The Uſe of the Sliding Rule in Arithmetic.

PROBLEM I.

To perform Multiplication by the Sliding Rule.

RULE.

Set 1 on the line B to either of the factors* on A; then againſt the other factor on B is the product on A.

EXAMPLES.

1. Required the product of 3 by 7?

Set 1 on B to 3 on A; then oppoſite to 7 on B is 21, the product on A.

2 What is the product of 15 by 8?

Set 1 on B to 8 on A, and oppoſite to 15 on B is 120 on A, the product.

3. Required the product of 24 by 18?

Set 1 on B to 24 on A; then oppoſite to 18 on B is 432 on A.

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* Any two numbers, whoſe product is required, are called factors.

REMARK.

When the product extends to three figures, it often happens that the unit figure cannot be immediately diſtinguiſhed on the rule: this, however, is eaſily obtained by multiplying the unit figures in the factors. Thus, in the preceding example, 4 multiplied by 8 is 32; hence the unit figure of the product muſt be 2.

PROBLEM II.

To perform Diviſion by the Sliding Rule.

RULE.

Set the diviſor on B to the dividend on A; then againſt 1 on B is the quotient on A.

EXAMPLES.

1. Divide 63 by 7?

Set 7 on B to 63 on A; then oppoſite to 1 on B is 9 on A, the quotient.

2. Divide 480 by 15?

Set 15 on B to 480 on A, and oppoſite to 1 on B is 32 on A, the quotient.

3. Divide 912 by 19?

Set 19 on B to 912 on A, and oppoſite to 1 on B is 48 on A.

REMARK.

In the ſame manner is a vulgar fraction reduced to a decimal. Thus, let it be required to reduce $\frac{3}{4}$ to a decimal fraction.

Set 4 on B to 3 on A, and oppoſite to 1 on B is .75 on A, the correſponding decimal fraction.

2. Reduce $\frac{5}{8}$ to a decimal?

Set 8 on B to 5 on A, and oppoſite to 1 on B is .625 on A, the decimal required.

PROBLEM III.

To perform Proportion, or the Rule of Three, by the Sliding Rule.

RULE.

In ſtating the queſtions in this rule, the firſt and ſecond terms are to be of the ſame name, and the third term is to be of the ſame name as that required.

Let, therefore, that term which is of the ſame name as the required one, be placed as the third term of the proportion. Then conſider, from the nature of the queſtion, whether the required term is to be greater or leſs than the third term. If it is to be greater, the leaſt of the other two terms is to be placed as the firſt term of the proportion, and the other as the middle term: But if it ought to be leſs, the greater of the two terms is to be placed as the firſt, and the leaſt in the middle.

Then, ſet the firſt term on B to the ſecond on A, and oppoſite to the third term on B, is the fourth term or anſwer on A.

EXAMPLES.

2. If 9 yards of cloth coſt 3 guineas, what is the value of 20 yards?

As 9 : 20 : : 63 ſh.

Now ſet 9 on B to 20 on A; then oppoſite to 63 on B is 140 on A, the anſwer in ſhillings; which reduced to pounds is L.7.

1. What is the value of 15 yards of cloth, when 40 yards coſt L. 24.

As 40 : 15 : : 24.

Now ſet 40 on B to 15 on A, and oppoſite to L. 24 on B is L. 9 on A, the anſwer.

3. The debts of a bankrupt amounted to L. 750, and his effects to L. 400; how much will be recovered for a debt due by him of L. 150?

As 750 : 150 : : 400.

Set 750 on B to 150 on A; then oppoſite to 400 on B is 80 on A, the anſwer.

4. If I lend a friend L. 450 during 10 months, how long ought he to lend me L. 300?

As 300 : 450 : : 10 m.

Now ſet 300 on B to 450 on A, and oppoſite to 10 on B is 15 months on A, the anſwer.

5. Bought 40 yards of fine cloth for L. 24. how may I ſell it per yard to gain L. 12 upon the whole?

L. 24 + 12 = L. 36.

And as 40 : 1 : : 36:

Set 40 on B to 1 on A; then oppoſite to L. 36 on B is $\frac{9}{10}$ of a pound, or 18 ſhillings on A: or oppo ſite to 720 (the number of ſhillings in L. 36) on B is 18 ſhillings, the anſwer on A.

6. A garriſon of 1500 men has proviſions for twelve months, how long will the proviſions laſt, at the ſame allowance, if the garriſon be reinforced by 500 men?

1500 + 500 = 2000 men.

As 2000 : 1500 : : 12 :

Set 2000 on B to 1500 on A; then oppoſite to 12 on B is 9, the anſwer in months on A.

PROBLEM IV.

To find the Square Root of any given number by the Sliding Rule.

RULE.

Set the middle diviſion on the line marked C to 10 on the line D; then, if the given number conſiſts of 2, 4, 6, &c. places of figures, it is to be found on the firſt, or left hand, half of the line C: but if it conſiſts of 3, 5, 7, &c. figures, it is to be found on the right hand part of the line; oppoſite to which on the line D, is the ſquare root required.

EXAMPLES.

1. What is the ſquare root of 64?

The middle diviſion or 1 on the ſlide being put to 10 on the line D; then oppoſite to 64 on the firſt part of the line C is 8, the ſquare root on D.

2. Required the ſquare root of 625?

The ſlide being placed as before, then oppoſite

625

625 on the ſecond part of the ſlide is 25, the ſquare root on the line D.

PROBLEM V.

Given the diameter of a circle to find its circumference by the Sliding Rule.

RULE.

Set 113 on B, to 355* on A; then oppoſite to the given diameter on B, is the circumference on A.

EXAMPLES.

1. Let the diameter of a circle be 40 inches, required the circumference?

Set 113 on B to 355 on A, and oppoſite to 40 on B is the circumference 125$\frac{2}{3}$ inches on A.

2. The diameter of a circle is 24, what is thecir cumference?

The ſlide being placed as before; then oppoſite to 24 on B is the circumference 75.3 on A.

PROBLEM VI.

Given the circumference of a circle to find the diameter.

RULE.

Set 355 on B to 113 on A, and oppoſite to the given circumference on B is the diameter on A.

EXAMPLES.

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* The proportion of 113 to 355 is very eaſily remembered. Thus let the three firſt odd figures be twice repeated in ſucceſſion; then, if the firſt three figures 113 repreſent the diameter of a circle, the laſt three, viz. 355, will be the circumference nearly.

EXAMPLES.

1. The circumference of a circle is 264, required the diameter?

Set 355 on B, to 113 on A; then oppoſite to 264 on B, is the diameter 84 on A.

2. Let the circumference of a circle be 150 feet, required the diameter?

The ſlide being placed as before; then oppoſite to 150 on B, is the diameter 47.8 on A.

PROBLEM VII.

To find a mean proportional between two given numbers.

RULE.

Set one of the given numbers upon C, to the ſame upon D; then oppoſite to the other number on C, is the mean proportional required on D.

EXAMPLES.

1. Required a mean proportional between 18 and 72?

Set 18 on C, to 18 on D; then oppoſite to 72 on C, is 36 on D, the mean proportional.

2. Required a mean proportional between 7 and 24?

Set 7 on C, to 7 on D; then oppoſite to 24 on C, is 13 nearly on D, the mean proportional.

CHAP. II.

Containing the Uſe of the Sliding Rule applied to the Menſuration of Wood, Stone, &c.

SECT. I.

Of Superficial Meaſure.

PROBLEM I.

Given the length and breadth in feet to find the ſuperficial content in feet.

RULE.

SET 1 on B to one of the given dimenſions on A; then oppoſite to the other dimenſion on B is the ſuperficial content in feet on A.

EXAMPLES.

1. The length of a room is 23 feet, and breadth 16 feet; required the ſuperficial content of the floor?

Set 1 on B to 16 on A, and oppoſite to 23 on B is 368 feet, the content in A.

2. How many feet of pavement is oppoſite to a houſe whoſe length is 45 feet, the breadth of the pavement being 7 feet?

Set 1 on B to 7 on A; then oppoſite to 45 on B is 315 feet on A.

PROBLEM II.

Given the length in feet, and breadth in inches, to find the ſuperficial content in feet.

RULE.

Set 12 on B, to the breadth in inches on A; then oppoſite to the length in feet on B, is the ſuperficial content in feet on A.

EXAMPLES.

1. Let the length be 15 feet, breadth 18 inches, required the ſuperficial content?

Set 12 on B, to 18 on A; then againſt 15 on B, is $22\frac{1}{2}$ feet, the ſuperficial content on A.

2. The length of a plank is 26 feet, the breadth at one end 16 inches, and at the other end 22 inches; required the ſuperficial content?

The mean breadth is $= \frac{16 + 22}{2} = 19$ inches.

Now ſet 12 on B, to 19 on A; then oppoſite to the length 26 feet on B, is the ſuperficial content $41\frac{1}{6}$ feet on A.

3. The length of a plank is 31 feet, and mean breadth 17 inches, required the ſuperficial content?

Set 12 on B, to 17 on A; then oppoſite to 31 on B, is the content 44 feet nearly on A.

PROBLEM III.

Given the length and breadth in inches, to find the ſuperficial content in feet.

RULE.

Set 144 on B, to the breadth on A; then oppoſite to the length on B, is the ſuperficial content in feet on A.

EXAMPLES.

1. Let the length be 46 inches, and breadth 28 inches, required the ſuperficial content in feet?

Set 144 on B, to 28 on A; then oppoſite to 46 on B, is 9 feet nearly, the ſuperficial content on A.

2. The length of a table is 62$\frac{1}{2}$ inches, and breadth 51 inches, required the ſuperficial content?

Set 144 on B, to 51 on A; then oppoſite to 62$\frac{1}{2}$ on B, is 22 feet on A.

3. A pane of glaſs is 22 inches by 15 inches, required its content? and ſuppoſing the price of glaſs to be 15d. per foot, the value of the pane is required?

Set 144 on B, to 15 on A; and oppoſite to 22 on B, is 2 feet $\frac{3}{10}$ths nearly, the contents on A.

Again, ſet 1 on B, to 2 $\frac{3}{10}$ths feet on A; and oppoſite to 15 on B, is 34$\frac{1}{2}$ nearly on A: hence the value of the pane of glaſs is 2s. 10$\frac{1}{2}$d. nearly.

4. The length of a board is 8 feet 7 inches, and breadth 10 inches, required the number of ſuperficial feet it contains?

Set 144 on B, to 10 on A; then againſt 103 inches, the length on B, is $7\frac{1}{10}$ feet nearly, the content on A.

5. A plank is 18 feet 7 inches long, breadth at one end 11 inches, and at the other end 17 inches, required the number of ſuperficial feet it contains, and its value at 5 d. per foot?

Half the ſum of 11 and 17 is 14 inches, the mean breadth. Now ſet 144 on B, to 14, the mean breadth on A; and oppoſite to the length 223 inches on B, is about $21\frac{6}{10}$ feet, the ſuperficial content on A. Then ſet 1 on B, to 21.6 on A; and oppoſite to 5 on B, is 108 d. or 9 s. on A, the value of the plank.

6. The length of a room is 16 feet, 4 inches, and breadth 13 feet, 1 inch; required the number of ſquare feet contained in the floor?

The length 16 feet, 4 inches = 196 inches; and the breadth 13 feet, 1 inch, = 157 inches. Now ſet 144 on B, to 157 on A; and oppoſite to 196 on B, is about 213 feet on A, the content required.

PROBLEM IV.

Given the length and breadth in feet, or in feet and inches, to find the ſuperficial content in ſquare yards.

RULE.

Find the ſuperficial content in feet by one of the preceding problems. Then ſet 9 on B, to 1 on A; and oppoſite to the content in feet on B, is the content in ſquare yards on A.

EXAMPLES.

1. Let the length be 27 feet, breadth 20 feet; required the content in ſquare yards?

Set 1 on B, to 20 on A; and againſt 27 on B, is 540 on A, the content in feet. Now ſet 9 on B, to 1 on A; and oppoſite to 540 on B, is 60 on A, the ſquare yards required.

Or, in this caſe, where the length and breadth are given in feet, ſet 9 on B, to 20 on A; then oppoſite to 27 on B, is 60 on A, as before.

2. The length of a room is 16½ feet, and breadth 14¼ feet; required the content of the floor in ſquare yards?

Set 9 on B, to 14¼ on A; and againſt 16½ on B, is 26⅛ on A, the content of the floor in ſquare yards. Hence it would require 26⅛ yards of carpeting, of 1 yard in breadth, to cover the floor.

3. Required the expence of painting one ſide of a room, whoſe length is 22½ feet, and height 11 feet, at 5d. per ſquare yard?

Set 7 on B, to 11 on A; and oppoſite to 22½ on B, is 27½, the ſquare yards on A. Then ſet 1 on B, to 5 on A; and againſt 27½ on B, is 137½d. on A; which, divided by 12, gives 11s. 5½d.

4. The length of a piece of ſide pavement is 86 feet, and breadth within the crib-ſtone 4 feet, 6 inches; required the number of ſquare yards it contains, and the expence of workmanſhip in laying down the ſame at 3½d. per ſquare yard?

Set 9 on B, to 4½ on A; and oppoſite to 86 on B, is 43 on A, the area in ſquare yards. Now ſet 1 on B, to 3½ on A; and oppoſite to 43 on B, is 150½ on A; which reduced gives 12s. 6½d.

5. Required the number of yards of paper ſufficient for one ſide of a room whoſe length is 22½ feet, and 10 feet high, the breadth of the paper being 21 inches?

Set 9 on B, to 22½ on A; and oppoſite to 10 on B, is 25 on A, the number of ſquare yards in the ſide of the room. Then, as the paper is only 21 inches in breadth, ſet 21 on B to 36 on A; and oppoſite to 25 on B, is 43 nearly on A, the yards of paper required.

PROBLEM V.

Given the diameter of a circle to find its area.

RULE.

Set .7854* on C, to 10 on D; and oppoſite to the diameter on D, is the area required on C, in the ſame terms as the diameter.

But if the diameter be given in inches, and the area required in feet; then ſet .7854 on C, to 12 on D; and oppoſite to the diameter on D, expreſſed in inches, is the area in ſquare feet on C.

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* The above number is the area of a circle whoſe diameter is 1.

EXAMPLES.

1. Required the area of a circle in ſquare inches, whoſe diameter is 6 inches?

Set .7854 on the ſlide to 10 on D; then oppoſite to 6 on D, is 28.3 nearly on C, the area in ſquare inches.

2. Let the diameter of a circle be 30 inches, required its ſuperficial content in feet?

Set .7854 on C, to 12 on D; and againſt 30 on D, is 4 feet $\frac{8}{10}$ths nearly, the area on C.

PROBLEM VI.

Given the circumference of a circle to find its area.

RULE.

Set 1 on C, to 3.545* on D; then oppoſite to the given circumference on D, is the ſuperficial content required on C, in the ſame terms as the circumference.

But if the circumference be given in inches, and the area required in feet; then ſet 1 on C to 42.53† on D, and oppoſite to the circumference in inches on D, is the area in feet on C.

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* The number 3.545 is the circumference of a circle whoſe area is 1.

† The number 42.53 is the circumference of a circle whoſe area is 12.

1. Let the circumference of a circle be 44 inches, required its area in ſquare inches?

Set 1 on C, to 3.545 on D; and oppoſite to 44 the circumference on D, is 154 on C, the area in ſquare inches.

2. The circumference of a circle is 168 inches, required the area in ſquare feet?

Set 1 on C, to 42.53 on D; and oppoſite to 168 on D, is 15 feet $\frac{6}{10}$ths on C, the area required.

SECTION II.

Of Solid Meaſure.

PROBLEM I.

Given the length in feet, and the breadth or thickneſs in inches, of equal ſided timber, to find the ſolid content in feet.

RULE.

Set 12 upon D, to the length on C; then oppoſite to the breadth or thickneſs on D, is the ſolid content in feet on C.

EXAMPLES.

1. The length of a log is 20 feet, and breadth 16 inches, the thickneſs being the ſame, required the number of cubic feet it contains?

Set 12 on D, to 20 on C; then oppoſite to 16 on D, is 35½ feet, the content on C.

2, Let the length of a log be 28 feet, and the ſide of the ſquare 14½ inches, required the ſolid content?

Set 12 on D, to 28 on C; and oppoſite to 14½ on D is 40⅞ on C, the content in cubic feet.

3. A block of marble is 7 feet long, and each ſide 2 feet, 4 inches; required the number of ſolid feet it contains?

Set 12 on D, to 7 on C; then oppoſite to 28 inches on D, is 38 feet on C, the ſolid feet required?

PROBLEM II.

Given the length in feet, the breadth and thickneſs in inches, to find the ſolid content in feet.

RULE.

Find a mean geometrical proportional between the breadth and thickneſs by Prob. VII. chap. 1. p. 15.; then ſet 12 on D, to the length on C; and oppoſite to the mean proportional on D, is the cubic feet required on C.

EXAMPLES.

1. The length of a log is 22 feet, breadth 19 inches, and thickneſs 13½ inches; required the number of cubic feet it contains?

Set 19 on C, to 19 on D; and oppoſite to 13½ on C, is 16 on D, the mean proportional. Now ſet 12 on D, to 22 on C; and oppoſite to 16 on D, is 39 on C, the required content in ſolid feet.

2. Let the length of a log of mahogany be 13½ feet, breadth 2 feet, 11 inches, and thickneſs 1 foot, 8 inches; required the content?

Set 20 on C, to 20 on D; and oppoſite to 35 on C, is 26½ on D, the mean proportional. Now ſet 12 on D, to 13½ on C; and oppoſite to 26½ on D, is 65½ feet on C, the required content in ſolid feet.

3. A bale is 8¼ feet long, 3½ feet broad, and 2 feet, 2 inches, deep; how many cubic feet doth it contain?

Set 26 on C, to 36 on D; and oppoſite to 42 on C, is 33 inches on D, the mean proportional. Now ſet 12 on D, to 8¼ on C; and oppoſite to 33 on D, is 62 feet on C, the anſwer.

PROBLEM III.

Given the length in feet, the breadth and thickneſs at each end in inches, to find the ſolid content in feet.

RULE.

Find the mean proportional between the breadth and thickneſs at each end, and let half their ſum be called the ſide of the mean ſquare. Then ſet 12 on D, to the length on C; and oppoſite to the ſide of the mean ſquare on D, is the ſolidity required on C.

EXAMPLES.

1. The length of a log is 32 feet, breadth at one

end 23 inches, and thickneſs 14 inches; and the breadth at the other end 19 inches, and thickneſs 12¾ inches; required the content?

Set 14 on C, to 14 on D; and oppoſite to 23 inches on C, is 18 on D. Again, place 19 on C, to 19 on D; and oppoſite to 12¾ on C, is 15½ on D. Now half the ſum of 18 and 15½ is 16¾ inches, the ſide of the mean ſquare.

Then ſet 12 on D, to 32 on C; and oppoſite to 16¾ on D, is 62 on C, the cubic feet required?

2. Let the length be 27½ feet, breadth at the greater end 20 inches, and thickneſs 12 inches; breadth at the leſs end 17 inches, and thickneſs 10 inches: required its content?

By proceeding as before, the mean proportional of the greater end will be 15½ inches, and of the leſs 13; half the ſum is 14½ inches. Now ſet 12 on D, to 27½ on C; and oppoſite to 14½ on D, is 40 on C, the number of cubic feet required?

PROBLEM IV.

Given the length of a tree in feet, and mean diameter in inches, to find its content.

RULE.

Set 1 upon C, to the mean diameter on D; and oppoſite to .7854 on C, is the ſide of a ſquare equal in area to the circle whoſe diameter is given.

Now ſet 12 on D, to the length on C; and oppoſite to the ſide of the ſquare on D, is the ſolid content on C.

REMARK.

In round timber, which tapers gradually, the circumference may be taken at the middle for the mean girt; or half the ſum of the circumferences at each end. If it tapers irregularly, the circumference is to be taken at the ends and at equal intervals; and their ſums, divided by the number of times the circumference has been taken, will be the mean girt or circumference. Thus let the circumferences at the ends, and at equal intervals, be 35, 28, 23, 20, and 14. Now their ſum 120, divided by their number 5, gives 24 inches, the mean girt.

EXAMPLES

1. The length of a tree is 42 feet, and mean diameter 1 foot, 8 inches, required its ſolid content?

Set 1 on C, to 20 on D; and oppoſite to .7854 on C, is 17¾ inches on D, the ſide of the ſquare. Now ſet 12 on D, to 42 on C; and oppoſite to 17¾ inches on D, is 91½ feet on C, the ſolidity.

2. Let the length of a ſpar be 52 feet, and mean diameter 14 inches, required the ſolid content?

Set 1 on C, to 14 on D; and oppoſite to .7854 on C, is about 12.4 on D. Now ſet 12 on D, to 52 on C; and oppoſite to 12.4 on D, is about 55.6 feet on C, the ſolidity required.

PROBLEM V.

Given the length of a tree in feet, and its circumference in feet or inches, to find its ſolid content in feet.

RULES.

I.

The circumference being given in feet.

Set 3.545 on D, to the length on C; and oppoſite to the circumference on D, is the ſolid content on C.

II.

The circumference being given in inches.

Set 42.53 on D, to the length in feet on C; then againſt the circumference on D, is the ſolid content on C *.

EXAMPLES.

The circumference being given in feet.

1. The length of a tree is 46 feet, and circumference 3 feet, required the ſolid content?

Set 46 on C, to 3.545 on D; then oppoſite to the circumference 3 feet on D, is very nearly 33 feet, the content on C.

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* Or multiply the circumference in inches by .2821 (which is the ſide of a ſquare equal to a circle whoſe circumference is 1); then multiply the ſquare of this product by the length in feet, which, being divided by 144, the quotient will be the anſwer in cubic feet.

2. The length of a tree is 50 feet, and mean circumference $4\frac{1}{2}$ feet, required the content?

The length 50 feet on C, being put to 3.545 on D, the beginning of the line C is removed to the right hand of $4\frac{1}{2}$ on D. In this caſe, therefore, take any multiple or part of the length, as its double, which is 100, and place it oppoſite to 3.545 on D, and againſt 4.5 on D is 161 on C, the half of which $81\frac{1}{2}$ is the number of cubic feet required.

EXAMPLES.

The circumference being given in inches.

1. Let the length of a tree be 20 feet, and mean circumference 29 inches, required its ſolid content?

Set 20 on C, to 42.53 on D; then oppoſite to 29 on D, is $9\frac{3}{10}$ feet, the ſolid content on C.

2. The length of a tree is 48 feet, and mean circumference 35 inches, required the ſolid content?

The length on C being ſet to 42.53 on D, there is no part of the ſlide oppoſite to the circumference on D. In this caſe, therefore, take any aliquote part of the length, as a fourth, which is 12. Now ſet 12 on C, to 42.53 on D; and oppoſite to 35 on D, is $8\frac{1}{8}$ on C; which, multiplied by 4, gives $32\frac{1}{2}$, the ſolid feet required.

3. The length is 56 feet, and circumference 40 inches, required the ſolid content?

Set 56 on C to 42.53 on D; and oppoſite to 40 at the left hand end of the line D, is $49\frac{1}{2}$ feet, the anſwer on C.

4. Let the length of a tree be 45 feet, and circumference 32 inches, required the content?

The length on C being ſet to 42.53 on D, there is no part of the ſlide oppoſite to 32 on D. Let therefore one-third of the length, which is 15, on C, be ſet to 42.53 on D; and oppoſite to 32 on D, is 8.5 on C; which, multiplied by 3, gives 25.5, the ſolid content.

Inſtead of taking aliquot parts of the length, the content may be found more generally by the following rule:

Set 10 at the end of the ſlide on C, to the circumference on D, and obſerve the number on C, which is oppoſite to 42.53 on D. Now ſet this number on B to the middle diviſion on A, and oppoſite to the length on B is the content on A.

Thus, in the above example, ſet 10 at the end of the line C, to 32 on D; and oppoſite to 42.53 on D, is 17.6 on C. Now ſet 17.6 on B, to 10 on A; and oppoſite to the length 45 feet on B, is 25.5, the content on A.

Again, in example ſecond, ſet 10 at the end of the ſlide on C, to the circumference 35 on D; and oppoſite to 42.53 on D, is 14.7 on C. Now ſet 14.7 on B, to the middle 10 on A; and oppoſite to the length 48 on B, is 32½ feet, the ſolid content on A.

REMARK.

The number of cubic feet in a box or bale being found by the preceding rules, its barrel bulk is obtained by doubling the feet, and pointing off the right hand figure as a decimal.

Thus, in example third, page 25, the contents of the bale in cubic feet is 62, which being doubled, and the right hand figure pointed off, gives 12.4, the barrel bulk required.

PROBLEM VI.

Given the length, and the breadth, and depth in feet, to find the ſolid content in yards.

RULE.

1. The ſection of the ſolid being rectangular.

Find a mean proportional between the breadth and thickneſs by Problem VII, page 15. Then ſet the length in feet on the line C on the ſlide, to 5.2* on the line D, and oppoſite to the mean proportional on D, is the content in cubic yards on C.

2. The ſection of the ſolid being triangular.

Find a mean proportional between the perpendicular and half the baſe, and proceed as before.

EXAMPLES.

1. Required the number of cubic yards in a portion of a canal, whoſe length is 150 feet, mean breadth 19 feet, and depth 8½ feet?

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* Or rather 5.196, which is the ſquare root of 27, the number of cubic feet in a cubic yard.

Set 8½ on C, to 8½ on D; and oppoſite to 19 on C, is 12¾ on D, the mean proportional.

Now ſet the length 150 feet on C, to 5.2 on D; and oppoſite to 12¾ on D, is the content in cubic yards 897, on C.

2. The length of a piece of through-cutting * is 30 feet, mean breadth 43 feet, and mean depth 6⅔ feet, required the content in cubic yards?

Set 6⅔ on C, to 6⅔ on D; and oppoſite to 43 on C, is about 16.9 on D. Now ſet 30 on C, to 5.2 on D; and oppoſite to 16.9 on D, is about 319 yards, the ſolid content on C.

3. Let the length of a piece of ſide-cutting be 80 feet, baſe 26 feet, and perpendicular height 14 feet, required the content in cubic yards?

In this example the ſection is a triangle, and therefore the mean proportional between the baſe and half the perpendicular is to be found, which, by proceeding as before, will be 13½ nearly. Now ſet 80 on C, to 5.2 on D; and oppoſite to 13½ on D, is 539, the content in cubic yards on C.

REMARK.

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* *Through-cutting*, *ſide-cutting*, *ſide-banking*, &c. are terms uſed in road-making. The firſt of theſe terms is when a piece of riſing ground is cut through in order to make the road more upon a level. When a road is made along the ſide of a hill, the quantity cut out of the declivity is called *ſide-cutting;* and *ſide-banking* is the quantity to be laid down to make up a part of the ſide of the road, that it may be of the proper breadth and heighth.

REMARK.

In order to render the calculations for aſcertaining the number of cubic yards in a piece of ſide-cutting as ſimple as poſſible, let the meaſures be taken in the following manner:

Stretch a line from the upper part of the ſide-cutting to the neareſt part of the outer edge of the road, and let the length of this line be called the *baſe;* then, by means of a divided rod, meaſure the neareſt diſtance between this line and the interſection of the horizontal and ſloping planes, which call the *perpendicular.* Now multiply the length of the piece of ſide-cutting by the perpendicular, and by half the baſe, each being expreſſed in feet; and this product, divided by 27, will give the ſolid content in cubic yards.

When the horizontal and ſlant ſides of the ſide-cutting are conſiderable, and nearly at right angles to each other, the perpendicular will be ſo long as not to be eaſily meaſured by the above method. In this caſe, therefore, the three ſides are to be meaſured. Now from half the ſum of the three ſides ſubtract each ſide ſeparately; then extract the ſquare root of the product of half the ſum of the ſides by the three differences; multiply this root by the length of the ſection, and the product, divided by 27, will be the content in cubic yards.

Or with the three ſides calculate the angle at the horizontal extremity. With this angle, the diſtance between the oppoſite edges of the ſide-cutting, the baſe or horizontal meaſure, and the length of the ſection, the content in cubic yards may be found.

The limits aſſigned to this tract will not admit of entering into a detail of the moſt proper methods of taking the various meaſures in ſide-cutting, ſide-banking, &c. nor into the different methods of making the calculations from theſe meaſures.

PROBLEM VII.

Given the length of the keel of a ſhip, and the extreme breadth, to find the tonnage.

RULE.

Set 1 on B, to the length of the keel on A; and oppoſite to the breadth on B, is a certain number on A.

Now ſet 188 on B, to the above found number on A; and oppoſite to the breadth on B, is the tonnage required on A.

EXAMPLES.

1. The length of the keel is 68 feet, and extreme breadth 22 feet; required the tonnage?

Set 1 on B, to 68 on A; and oppoſite to 22 on B, is 1500 on A. Now ſet 188 on B, to 1500 on A; and oppoſite to the breadth 22 on B, is 175 nearly on A, the tonnage required.

2. Let the length of the keel be 86 feet, and extreme breadth 28 feet; required the tonnage?

Set 1 on B, to 86 on A; and oppoſite to 28 on B; is 2400 on A. Now ſet 188 on B, to 2400 on A; and oppoſite to 28 on B, is 358½ tons on A.

REMARK.

The tonnage may be more eaſily found by the following rule:

Set 13¾, or rather 13.71 *, on D, to the length of the keel on C; then oppoſite to the extreme breadth on D, is the tonnage on C.

EXAMPLE.

Let the length of the keel be 78 feet, and extreme breadth 24½ feet; required the tonnage?

Set 13.71 on D, to 78 on C; then oppoſite to 24½ on D, is 249 on C, the tonnage required.

By a ſliding rule of a late conſtruction the tonnage may be found as follows:

Set 1 on A, to 94 on D; now bring the half breadth on C, to the breadth on D; and oppoſite to the length of the keel on A, is the tonnage required on B.

EXAMPLE.

Let the length of the keel be 70 feet, and extreme breadth 24 feet; required the tonnage?

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* The number 13.71 is the tonnage point, and may be found on the rule by ſetting 10 at the middle of C, to 10 on D; then oppoſite to 188 (equal to twice 94) on C, is 13¾ nearly on D; or it is the ſquare root of 188.

Set 1 on A, to 94 on D; then bring the half breadth 12 on C, to the breadth 24 on D; and oppoſite to the length 70 feet on A, is $214\frac{1}{2}$ nearly, the tonnage on B.

SCHOLIUM.

The following method of taking the dimenſions for the tonnage is that which is uſed in the King's ſervice:

Let fall a perpendicular from the foreſide of the ſtern at the height of the hauſe-holes, and another perpendicular from the back of the main-poſt at the height of the wing-tranſom. From the length between theſe two perpendiculars deduct three-fifths of the extreme breadth, and alſo as many times $2\frac{1}{2}$ inches as there are feet in the height of the wing-tranſom above the upper edge of the keel, the remainder is the length of the keel for tonnage; with which, and the extreme breadth, the tonnage is to be found by the preceding rules.

CHAP.

CHAP. III.

Containing the Deſcription of the Ship-Carpenter's Sliding Rule, commonly called Mungo Murray's *Rule; and its uſe in the conſtruction of Maſts, Yards, Capſtan-barrels, &c.*

THIS rule is uſually two feet long, having a joint in the middle, and a ſlide as in the common ſliding rule already deſcribed.

SECT. I.

Of the Lines upon one ſide of the Rule.

THERE are four lines of numbers, two upon the ſlide, marked B and C; one above the ſlide, marked A; and one below, marked D. This laſt line is inverted, and is ſo diſpoſed, that 12 on it is exactly oppoſite to 12 on the upper line of numbers on A.

The ſuperficial content is found by the two upper lines of numbers A and B, exactly in the ſame manner as by the common rule before deſcribed. But the operation for finding the ſolid content of timber, ſtone, &c. is much eaſier, and is as follows;

PROBLEM I.

Given the length in feet, and the breadth and thickneſs in inches, to find the ſolid content in feet.

RULE.

Set the breadth on the line C on the ſlide, to the thickneſs on the inverted line of numbers D; then oppoſite to the length in feet on the upper line A, is the ſolid content in feet on B.

EXAMPLE.

Let the length of a log be 27 feet, breadth 19 inches, and thickneſs 13 inches, required the ſolid content?

Set 19 on C, to 13 on D; and oppoſite to 27 on A, is 46 feet and above a quarter on B, the ſolid content required.

There are lines for conſtructing polygons of 8, 10, and 12 ſides; theſe are uſually called the 8, 10, and 12 ſquare lines. The 8 ſquare lines are for making maſts and yards; and the 10 and 12 ſquare lines are for making barrels of capſtans. The 8 ſquare lines are on the inner edge of each leg of the rule, and are marked M. E. ſignifying *middle*, *end*; and thoſe for the 10 and 12 ſquare lines are upon the ſame ſide of the rule as the ſlide, but on the other leg, except the laſt line, of which there is a part on each leg. Theſe lines for the 10 and 12 ſquares are five in number, and are titled as follows: 10

Sqr. B. S.; 10 Sqr. S. S.; 12 Sqr. 2 S.; 12 Sqr. 4 S.; and 10 L. D. Sqr. In the 10 ſquare lines, B. S. ſignifies *broadeſt ſide;* S. S. *ſmalleſt ſide;* and L. D. the *length* of the *diameter* paſſing through any two of the oppoſite corners, or angular points of the polygon. Alſo, in 12 ſquare lines, 2 S. ſignifies the breadth to be laid off from the middle line upon any *two* of the oppoſite *ſides;* and 4 S. that to be laid off from the middle line on all the four *ſides.* The four firſt of theſe lines begin immediately after their titles; and the fifth or laſt begins at the left hand end, and terminates at the extremity of the other leg.

USE OF THE EIGHT SQUARE LINES.

The wood being previouſly ſquared, that is, of the ſame breadth and thickneſs, and the ſides perpendicular to each other; then let lines be drawn along the middle of each ſide. Now from the line marked M. on the inner edge of the rule, take the number anſwering to the breadth or thickneſs in inches, and lay it off both ways from each middle line; and through theſe points let lines be drawn parallel to the middle line; then the angular pieces between theſe lines being cut off, the wood will be eight ſquare, as required.

Or the number anſwering to the breadth or depth being taken from the line marked E, and laid off from the edge, will give the ſame points as before.

In making a maſt, the log is to be ſquared, and lines ſtruck along the middle of each ſide. The places of the partners, quarters, &c. are to be marked; then the numbers from the line M, anſwering to the ſeveral breadths at the partners, quarters, &c. are to be taken and laid off from the middle line at theſe places reſpectively, and lines are to be ſtruck between each adjacent pair of points.

In making a yard, the diviſions anſwering to the thickneſs at the ſlings, quarters, and yard-arm, are to be taken from the line M, and laid off from the middle line as before.

REMARK.

The number to be laid off from the middle line may be found independent of the line M, as follows:

Set 100 on B, to 20.7 on A; then oppoſite to the diameter on B, is the number required on A*.

Thus let the diameter be 16 inches, to find the number to be laid off on each ſide of the middle line.

Set 100 on B, to 20.7 on A; then oppoſite to 16 on B, is 3.3 on A.

The number to be laid off from the edge may be found as follows:

Set 100 on B, to 29.3 on A; and oppoſite to the breadth or thickneſs on B, is the number to be laid off from the edge on A †.

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* Or, multiply the number .2071 by the diameter, and point off four figures to the right hand.

Thus let the breadth be 24 inches, required the number to be laid off from the edge?

Set 100 on B, to 25.3 on A; and oppoſite to 24 on B, is 7.03 on A, the required number.

USE OF THE TWELVE SQUARE LINES.

The wood being of an equal breadth and thickneſs, and the ſides perpendicular or ſquare to each other, take the number anſwering to the breadth or depth in inches from the marked 12 Sqr. 2 S. and lay it off from the middle both ways on any two oppoſite ſides of the wood, and draw lines through theſe points parallel to the middle line. Alſo, lay off, from the middle line on each of the four ſides, the extent from the line marked 12 Sqr. 4 S. anſwering to the breadth or thickneſs in inches, and draw lines through theſe points parallel to the middle line. Now cut off the angular pieces of wood between the lines 2 S. and 4 S.; and upon this new ſide lay off, from the line 4 S. double the meaſure from the line 12 Sqr. 4 S.; and the angular piece of wood between this line and the adjacent line 4 S. being cut off, will form the 12 ſquare required.

REMARK.

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† Or, multiply the conſtant number .2929 by the breadth or thickneſs, and the product, four figures being pointed off towards the right hand, will be the number required.

REMARK.

The number to be laid off from the middle line may be found in the following manner.

Set 100 on the line B, to 13.4 on A; and oppoſite to the breadth on B, is the number on A, anſwering to that from the line marked 12 Sqr. 4 S*.

And ſet 100 on B, to 28.9 on A; and oppoſite to the breadth on B, is the number on A, anſwering to the meaſure from the line 12 Sqr. 2 S†.

Thus, let the diameter be 18 inches, required the meaſures to be laid off from the middle line?

Set 100 on B, to 13.4 on A; and oppoſite to 18 on B, is 2.4 inches, the meaſure anſwering to that from the line 12 Sqr. 4 S.

Alſo, ſet 100 on B, to 28.9 on A; and oppoſite to 18 on B, is 5.2 inches, the meaſure to be laid off on any two of the oppoſite ſides.

USE OF THE TEN SQUARE LINES.

The wood intended for a ten-ſquare barrel muſt be

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[*] Or, multiply the conſtant number 134 by the breadth, and the product, three figures being pointed off to the right hand, will be the meaſure to be laid off from the middle line on each of the four ſides.

[†] Multiply the conſtant number 2887 by the breadth, and the product, four figures being pointed off to the right hand, will be the meaſure to be laid off from the middle line on two of the oppoſite ſides.

be broader than it is thick. When the thickneſs is given, the breadth may be found by taking the correſponding number from the line marked 10 L. D. Sqr. Thus, if the thickneſs is 9 inches, then the breadth will be the extent between the beginning of the line 10 L. D. Sqr. and the diviſion 9, which will be about $9\frac{1}{2}$ inches.

Now, the wood being made to the proper breadth and thickneſs; take, from the line marked 10 Sqr. B. S. the number anſwering to the thickneſs in inches, and lay it off both ways from the middle line on each of the broadeſt ſides, and through theſe points draw lines parallel to the middle line. Again, take from the line marked 10 Sqr. S. S. the number anſwering to the thickneſs in inches, and lay it off both ways from the middle line on each of the ſmalleſt ſides, and let lines be drawn through theſe points parallel to the middle line. Now cut off the angular pieces between theſe lines; and, upon the ſides thus formed, lay off, from each of the lines drawn on the broadeſt ſide, the interval between theſe lines, which is one of the ſides of the ten ſquare; then through theſe points draw lines parallel to the former lines, and the angular pieces between theſe lines and the middle lines on the ſmalleſt ſides being cut off, the wood will then be ten-ſquared.

REMARK.

The thickneſs or ſmalleſt ſide being given, the breadth may be found by ſetting 20 on B, to 21* on A; and oppoſite to the thickneſs on B, is the breadth on A †; and, converſely, if the breadth be given, ſet 21 on B, to 20 on A; and oppoſite to the breadth on B, is the thickneſs on A ‡.

In order to find the meaſure to be laid off from the middle line on each of the broadeſt ſides, ſet 100 on B, to 30.9 on A; and oppoſite to half the breadth on B, is the meaſure required on A, that is, the meaſure from the line 10 Sqr. B. S ‖.

And to find the meaſure to be laid off from the middle line of the ſmalleſt ſide, ſet 100 on B, to 44.9 on A; and oppoſite to half the breadth on B, is the meaſure on A, to be laid off from the middle line of each of the ſmalleſt ſides, and which will anſwer to the meaſure from the line 10 Sqr. S. S ¶.

Upon the inner ſide of the ſlide are diviſions for aſcertaining, when compared with the line of numbers,

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[*] Or, more exactly, 21.03855.

[†] This may be done without the aſſiſtance of the rule as follows: Multiply the number 1.0514622 by the ſmalleſt ſide, and the product will be the breadth.

[‡] Multiply the decimal .9510565, or, for common practice, 951 by the breadth, and the product will be the ſmalleſt ſide.

[‖] Or, multiply the decimal .309 by half the broadeſt ſide, and the product will be the quantity to be laid off from the middle line of that ſide.

[¶] Or, multiply the decimal .449 by half the breadth, and the product will be the meaſure required.

bers, the lengths of maſts, yards, and the diameters of each.

This line contains three principal diviſions: The firſt diviſion, or that for maſts, contains the following ſubdiviſions, viz.

Brh. ſignifying the extreme breadth of the ſhip.
m. - - main-maſt.
f. - - fore-maſt.
z. - - - mizen-maſt.
b. - - bowſprit.
mt. - - - main-top-maſt.
ft. - - - fore-top-maſt.
zt. - - mizen top-maſt.
mg. - - main top-gallant-maſt.
fg. - - - fore top-gallant-maſt.

In the ſecond or middle diviſion,

G. D. ſignifies Gun Deck.
m. - - - main-yard.
f. - - - fore-yard.
z. - - - mizen-yard.
mt. - - - main top-ſail-yard.
ft. - - - fore top-ſail-yard.
mg. - - - main top-gallant-yard.
zt. - - - mizen top-ſail-yard.
fg. - - - fore top-gallant-yard.

And the third and laſt diviſion, for finding the diameters of maſts and yards, contains the following ſubdiviſions, viz.

Beginning at F. L. ſignifying Feet in Length.
b. - - bowſprit.

lm. - lower maſts.
ly. - - lower yards.
zm. - mizen-maſt.
ty. - - top-ſail-yards.
gy. - - top-gallant-yards.
And zy. - mizen-yards.

In ſhips of war, the length of the main maſt is adapted to the extreme breadth; and the lengths of the other maſts are deduced from that of the main maſt, agreeable to received proportions. The lengths of the yards are adapted to the length of the gun-deck; and the diameters of each are proportioned to the length of the maſt or yard reſpectively. The uſe of theſe lines will be obvious from the following problems:

PROBLEM I.

Given the extreme breadth of a ſhip to find the lengths of the maſts, top-maſts, &c.

RULE.

Take out the ſlide, and turn it ſo that the inner ſide may be uppermoſt, and the extremity, marked Brh. towards the right hand. Now move the ſlide until the diviſion Brh. be exactly oppoſite to the extreme breadth in feet on the upper line numbers A; then oppoſite to each of the diviſions m. f. z. &c. on the ſlide, are the correſponding lengths of the maſts in yards reſpectively.

EXAMPLE.

Let the extreme breadth be 30 feet, required the lengths of ſeveral maſts, topmaſts, &c.?

Set the firſt diviſion Brh. on the ſlide, to the extreme breadth 30 on the line A; then oppoſite to m. is $22\frac{1}{3}$ yards, the length of the mainmaſt on A.

f.	$20\frac{1}{3}$	fore maſt.
z.	$19\frac{1}{2}$	mizen maſt.
b.	14	bowſprit.
mt.	$13\frac{3}{4}$	main top-maſt.
ft.	$12\frac{2}{5}$	fore top-maſt.
zt.	10	mizen top-maſt.
mg.	7	main top-gallant-maſt.
fg.	$6\frac{1}{2}$	fore top-gallant-maſt.

PROBLEM II.

Given the length of the gun-deck to find the lengths of the yards.

RULE.

Set GD on the ſlide, to the length of the gun-deck on the line A; then oppoſite to the ſeveral diviſions on this part of the ſlide are the lengths of the yards in feet.

EXAMPLE.

Let the length of the gun-deck be 138 feet, required the lengths of the yards?

Set GD on the ſlide, to 138 on the line A; then oppoſite to the ſeveral diviſions on the ſlide are the correſponding lengths of the yards on A, viz.

Op. to m. is 80 feet, the length of the main yard.
f. 70, - - fore yard.
z. 67, - - mizen yard.
mt. 58, - - main top-ſail-yard.
ft. 50^{1}, - fore top-ſail-yard.
mg. 40, - - main top-gallant-yard.
zt. 38, - - mizen top-ſail-yard.
And fg. 35, - - fore top-gallant yard.

PROBLEM III.

Given the length of a maſt or yard to find the diameter of the maſt at the partners, or of the yard at the ſlings.

RULE.

Set the diviſion F. L. on the ſlide, to the length in feet of the given maſt or yard on the line A; and oppoſite to the diviſion repreſenting the maſt or yard, is the diameter in inches on the line A.

EXAMPLES.

1. Let the length of the main-maſt be 80 feet, required its diameter at the partners?

Set F. L. on the ſlide, to 80 on A; then oppoſite to *lm* on the ſlide, is the diameter 25 inches on A.

2. The length of a main top-maſt is 60 feet, required its diameter?

Set F. L. on the ſlide, to 60 on A; and oppoſite to *mt* on the ſlide, is $18\frac{1}{4}$, the diameter on A.

3. The length of a main yard is 70 feet, required its diameter at the ſlings?

Set F. L. on the ſlide, to 70 on A; and oppoſite to ,*y* on the ſlide, is 17 inches, the diameter of the yard at the ſlings.

SECT. II.

Of the lines upon the other ſide of the Rule.

Upon the other ſide of the rule, with reſpect to that in which is the ſlide, beſides a line of inches, are two lines of equal parts, one on each leg. Each principal diviſion in theſe lines, which is about three quarters of an inch, is divided into twelve equal parts: hence each primary diviſion may repreſent feet, and the intermediate will repreſent inches. By theſe lines a ſcale may be laid down of any propoſed length; a given line may be divided into any propoſed number of equal parts; and the various operations in proportion may be performed. Theſe will be illuſtrated by the following problems:

PROBLEM I.

To lay down a ſcale of any given length.

RULE.

Take the given length which is to repreſent twelve feet on the ſcale, and open the rule until the diviſions repreſenting twelve on each leg be exactly equal to the above extent ; then the intervals between the intermediate principal diviſions will repreſent feet, and between the ſubdiviſions feet and inches.

EXAMPLE.

Let it be required to lay down a ſcale ſo that $\frac{5}{8}$ths of an inch may repreſent one foot?

As $\frac{5}{8}$ths of an inch is to repreſent one foot, then $\frac{5}{8} \times 12 = 8\frac{1}{2}$ inches, will repreſent 12 feet. Now take $8\frac{1}{2}$ inches from the ſcale of inches, and open the rule until the diviſions 12 on the neareſt parts of the lines be equal to this extent ; then the extent between 1 and 1 will repreſent 1 foot ; that between 2 and 2 will be 2 feet ; between 4.3 and 4.3 will repreſent 4 feet, 3 inches, &c. ; and hence the ſcale may be laid down upon paper.

PROBLEM II.

To divide a given line into any propoſed number of equal parts.

RULE.

Make the given line a parallel extent* between the diviſions on the oppoſite legs, repreſenting the number of parts into which the line is to be divided; then lay off the intermediate extents upon the line, and it will be divided accordingly.

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* A parallel extent is an extent meaſured in a direction acroſs between any two correſpondent diviſions ; and an extent meaſured along the line from the centre is called a *lateral extent*.

EXAMPLE.

Let it be required to divide a line 4½ inches long into 7 equal parts?

Take 4½ inches from the ſcale of inches, and make it a parallel extent between 7 and 7 on the line of equal parts; then the ſeveral extents between 1 and 1, 2 and 2, &c. being laid off upon the line, will divide it into 7 equal parts.

PROBLEM III.

To find a fourth proportional to three given numbers.

RULE.

Take the ſecond term from the line, and make it a parallel extent between the diviſions repreſenting the firſt term; then the parallel extent between the diviſions repreſenting the third term, being aplied to the line from the beginning, will give the fourth term.

EXAMPLE.

Required a fourth proportional to the numbers 14, 6, and 9?

Take 6 from the line, and open the rule until the extent between 14 and 14 is exactly equal to

6; then the extent between 9 and 9 being laid off from the centre, will meaſure 3 and $\frac{10}{12}$ths nearly.

Of the lines for determining the thickneſs of maſts and yards at the quarters, &c.

Within the above lines of equal parts are four lines on each leg of the rule for making maſts and yards. Theſe lines begin at the right hand extremity, and, if produced, would interſect in the centre of the joint.

The firſt or innermoſt line is for making maſts. At the right hand extremity it is marked P. ſignifying *partners*. The 1ſt, 2d, and 3d quarters are marked. Alſo hs. is for *hounds;* and at the left hand extremity hd. for *maſt-head*.

The ſecond, or next line, marked B. for *bed*, at the right hand end, is for making bowſprits. The quarters are marked as before; and at its other extremity are the letters B. C. ſignifying the *breadth* at the *cape*.

The third line is for making yards. At the right hand extremity is marked S. ſignifying *ſlings*. The quarters are marked; and at the other end are the letters Y. A. for *yard-arm*.

The fourth, or outermoſt line, is for a mizen yard: upon which, at the right hand end, S. ſtands for *ſlings;* L. A. for *lower arm*. The uſe of theſe lines will be obvious from the following problem:

PROBLEM

PROBLEM.

Given the length of a maſt, and the diameter at the partners to make it.

RULE.

Let a line be ſtruck along the middle of two of the oppoſite ſides of the log intended for the maſt; upon which mark the place of the partners and hounds, and divide this interval into four equal parts. Now with a pair of compaſſes take half the breadth at the partners, and open the rule until the diſtance between the points P. and P. at the end of the rule, be exactly equal to this extent; then take the extent between the dots at the firſt quarter on the rule, and lay it off at the firſt quarter on the maſt from the middle line on each ſide. In like manner, lay off the other quarters, the hounds and maſt head; and let lines be ſtruck between the points, and hew off the wood accordingly. Proceed, in like manner, with the other two ſides; then eight-ſquare it by the preceding rules, and finiſh it off as uſual.

A yard is conſtructed nearly in the ſame manner. The diameter at the ſlings is to be made a parallel extent between S. and S. on the rule; and the quarters and yard-arm are to be taken from the rule, and laid off from the middle line as before.

Upon one of the outer edges of the rule the foot is divided into 100 equal parts; and upon the other edge are two lines of numbers, one a ſingle line, and the other a triple line. By theſe lines the cube root of any given number is found by inſpection, and converſely. Thus, find the given number on the triple line, and oppoſite to it on the ſingle line is the root required. In this operation, it muſt be obſerved, that if the number whoſe root is required conſiſts of 1, 4, 7, &c. places of figures, it is to be found on the firſt part of the triple line; if it conſiſts of 2, 5, 8, &c. places of figures, it is to be found on the middle part; and if it has 3, 6, 9, &c. places of figures, it will be found on the laſt part; oppoſite to which, on the ſingle line, is the root required. If the number of figures in the propoſed cube be three or under, the root will conſiſt of one figure; from three to ſix places incluſive, the root will conſiſt of two figures; from ſix to nine incluſive, of three figures, &c.

This line is alſo uſeful in finding the dimenſions of a ſolid ſimilar to one given.

FINIS.

Publiſhed, by Dr MACKAY,

A TREATISE on the THEORY AND PRACTICE OF FINDING THE LONGITUDE AT SEA OR LAND; to which are added, *Various Methods of determining the* LATITUDE *of a Place, and* VARIATION *of the* COMPASS, *with* NEW TABLES, in two Volumes Octavo, Price Twelve Shillings in boards.—The following Character of this Work is given in the Monthly Review and Britiſh Critic for March 1794.

" From the preceding abſtract of the contents of this valuable work, our readers will be better able to judge what information they may derive from it, than they could have been by any detached extract which we may have ſelected. Of the Author's extenſive and accurate acquaintance with the ſubject to which he has directed our attention, none who peruſe what he has written can entertain any doubt. To the Navigator and Aſtronomer, and alſo to the Practical Geographer and Surveyor, this work will be inſtructive and uſeful. We cannot conclude without expreſſing our wiſhes, that the author may be ſuitably encouraged in the proſecution of the plan which he has undertaken, of publiſhing a diſtinct Treatiſe on the Theory and Practice of Navigation, and another in three volumes on the Theory and Practice of Aſtronomy." *Monthly Review.*

" Throughout the articles which we have ſpecified, Mr Mackay's zeal and ability to inſtruct his readers are equally manifeſt. He has not only written fully on the ſubjects themſelves, but has alſo introduced ſuch collateral matter as was likely to ſatisfy the inquiſitive reader, and illuſtrate his principal deſign. In his deſcription of inſtructions, we meet with the minuteneſs of an artiſt; in his application of them, we find the attention of an accurate obſerver; and in the demonſtration of his rules, we ſee the preciſion of a practiſed geometrician." *Britiſh Critic.*

See alſo *L'Eſprit des Journeaux* for April 1794, *Critical Review* for Auguſt 1794, *New Annual Regiſter* for 1793, &c.